Two Career Fire Fighters Die in a Rapid Fire Progression While Searching for Tenants—Ohio

Executive Summary

On January 26, 2014, a 42-year-old male career fire fighter/EMT-B and a 31-year-old male career fire fighter/EMT-B died in a two-story attached garage apartment fire. Four engines, one truck, one rescue, and a battalion chief were initially dispatched to a structure fire with reported people inside the building. Battalion Chief 1 reported smoke showing from two blocks away. Engine 3 was first on-scene followed by Battalion Chief 1. Battalion Chief 1 assumed command and assigned Engine 3 who had parked in front of the building (Side Alpha) as Fire Attack. Engine 13 and Rescue 13 had arrived on-scene next and were assigned as Search and Back-up, respectively. Engine 6 arrived on scene and parked in the rear parking lot on Side Charlie. Engine 6 was assigned to Fire Attack on Side Charlie. Truck 17 arrived on scene, pulled past Engine 3, and was ordered to open up the roof. Engine 17 was assigned as the rapid intervention team (RIT). The incident commander was informed by an occupant that all occupants were out of the structure but a dog was on the second floor. Engine 3 made entry through a second-floor window and Engine 6 was at a second-floor doorway (on Side Delta). Both companies were advancing a 1¾-inch hoseline into the second-floor apartment. Battalion Chief 3 arrived on scene and reported heavy fire in the rear. Heavy, black smoke started coming out of the garage door and second-floor window on Side Alpha. Engine 3 transmitted a Mayday. Ten seconds later, the officer of Engine 3 came out the second-floor doorway onto the landing and called another Mayday. Engine 7 arrived on scene and was assigned to assist the RIT in locating the two fire fighters from Engine 3. Engine 7 reported heavy heat conditions in the second-floor apartment while trying to search. The Engine 17 RIT found one of the fire fighters from Engine 3 and removed him through the side door (Side Delta) and down the stairs to Life Squad1for treatment. The Engine 17 RIT had to change air cylinders while Engine 19 and the safety officer (officer from Engine 19) continued the search for the other fire fighter. The Engine 17 RIT had just re-entered the structure when the second fire fighter was found. Both fire fighters were transported to the hospital but died from their injuries.

Engine 3 made entry into the window on the second floor.
(Photo courtesy of the Fire Department.)

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Contributing Factors

- *Arson*
- *Risk assessment and Scene size-up*
- *Resource deployment*
- *Fireground tactics*
- *Inadequate water supply*
- *Crew staffing*
- *No full-time safety officer*
- *No sprinkler system in the building*

Key Recommendations

- *Fire departments should ensure that the incident commander conducts an initial 360-degree size-up and risk assessment of the incident scene to determine if interior fire-fighting operations are warranted.*
- *Fire departments should integrate current fire behavior research findings developed by the National Institute of Standards and Technology (NIST) and Underwriter's Laboratories (UL) into operational procedures by developing standard operating procedures, conducting live fire training, and revising fireground tactics.*
- *Fire departments should ensure all fireground ventilation is coordinated with fire-fighting operations.*
- *Fire departments should ensure that the incident commander establishes a stationary command post for effective incident management, which includes the use of a tactical worksheet, efficient fireground communications, and a personnel accountability system.*
- *Fire departments should ensure that all companies are staffed with an officer on the fireground.*
- *Fire departments should ensure that the incident commander assigns a safety officer as early in the incident as possible as defined by NPFA 1561 Standard on Emergency Services Organization Incident Management System and Command Safety.*

2014
02

Death in the line of duty...

NIOSH Fire Fighter Fatality Investigation and Prevention Program

A summary of a NIOSH fire fighter fatality investigation

April 14, 2015

Two Career Fire Fighters Die in a Rapid Fire Progression While Searching for Tenants—Ohio

Introduction

On January 26, 2014, a 42-year-old male career fire fighter/EMT-B and a 31-year-old male career fire fighter/EMT-B died in a two-story attached garage apartment fire. On January 27, 2014, the U.S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this incident. On January 28–February 2, 2014, a general engineer, an occupational safety and health specialist, and an investigator from the NIOSH Fire Fighter Fatality Investigation and Prevention Program traveled to Ohio to investigate this incident. The NIOSH investigators met with members of the career fire department and the county dispatch center. NIOSH investigators interviewed the incident commander and fire fighters who were on scene at the time of the incident. The NIOSH investigators visited the incident site and took photographs. On February 27–28, 2014, the general engineer returned to Ohio to finish collecting information, meet with the International Association of Fire Fighters local president, and pick up two self-contained breathing apparatus (SCBA) to be evaluated by the NIOSH National Personal Protective Technology Laboratory.

Fire Department

This career department consists of 541 uniformed and civilian members. The rank structure is fire chief, assistant chief, deputy chief, battalion chief, captain, lieutenant, and fire fighter. The department is divided into seven bureaus: Fire Administration, Field Operations, Fire Prevention, Fire Training, Emergency Medical Service (EMS), Fire Communications, and Special Operations. In 2013, the fire and rescue department responded to 53,765 total incidents, of which 47,458 were EMS incidents.

The fire and rescue department's Field Operations Bureau manages the daily emergency operations under a platoon system. This system consists of platoons A, B, and C. Each platoon works a 24-hour tour of duty with 48 hours off duty. The minimum daily staffing at 18 fire stations is 103 fire fighters, which includes officers, such as lieutenants and captains. Each station has a captain assigned as the station commander/company commander, charged with the responsibility of the condition of the station and all the apparatus and department-owned equipment stored within. Stations also have lieutenants assigned as company commanders whose responsibilities include command of one or more units and the members assigned during their tour of duty. The department serves a population of more than 284,000 people in a geographic area of approximately 84 square miles.

The city is divided into three battalions. Each battalion is managed by a battalion chief, with one of these battalion chiefs assigned as "senior" battalion chief who is responsible for citywide staffing and activities.

The fire and rescue department operates with 17 engines, 2 heavy rescues, 3 ladder trucks, 5 advanced life support ambulances designated as life squads, and 10 basic life support ambulances designated as rescue transports. In addition to responding to emergencies, line personnel responsibilities include

safety, training, building familiarization, and maintenance of apparatus, equipment, and the station. In addition to day-to-day emergency response, the fire and rescue department also deploys several technical rescue teams: Hazardous Materials Team, Confined Space/Trench Rescue, Water Rescue, High-Angle Rope Rescue, and operates the department's Fire Boat.

The department also operates a Fire Prevention Bureau, whose activities include fire inspections, fire investigations, and building plan reviews. The Training Bureau staff provides recruit training, officer training, continuing education, cardiopulmonary resuscitation, and EMT-Basic and EMT-Paramedic certification for the department. The Training Bureau provides continuing education for basic life support and the county EMS provides advanced life support for all county and fire department paramedics. The Special Operations Bureau was formed in September 2002 and is responsible for the department's preparedness and response capability to chemical, biological, incendiary, radiological, and nuclear incidents. The bureau also oversees the department's technical rescue programs and performs major event planning. In addition, members of the bureau manage state and federal grant programs and represent the department's interests on several committees.

The Fire Communications Bureau's overall mission is to receive phone, radio, or computer messages from 911 call takers, the general public, or other agencies; interpret or evaluate these messages; and then take the proper action by dispatching the appropriate resources to the emergency or handling the non-emergency situation. The Communications Bureau is part of the county's 911 Center. Fire lieutenants oversee fire dispatch operations and are directly involved in all unusual or working fire incidents such as first-, second-, and third-alarm fires; HAZMAT; water rescue; and confined space incidents. The fire and rescue department operates on the county's 800-MHz radio system. The Communications Bureau is responsible for the operation and maintenance of all department radios, alert receivers, and other communications equipment that operate on the system.

Training and Experience

The state of Ohio permits the authority having jurisdiction to determine the level of certification for fire fighters with the exception of all full-time career fire fighters who are required to have Level II certification.

In the state of Ohio there are three certification levels for fire fighters: Volunteer, Level I, and Level II:

- Volunteer Fire Fighter requires 36 hours of training in basic concepts, equipment, and techniques. This training does not include fighting real fires. After successful completion, the student may take the state certification examination.
- Fire Fighter I requires a minimum of 120 hours training that includes a comprehensive introduction of basic fire-fighting concepts and skills and permits the students to practice the skills, including live fire training.
- Fire Fighter II requires a minimum of 240 hours training that includes additional practice of skills on advanced rescue and prevention concepts, including participation in live fire training evolutions. Level II certification is required for full-time paid (career) fire fighters.

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The recruit school is operated by the fire and rescue department training bureau which has officers at the local community college. The curriculum is 480 hours, which exceeds the state requirements of 240 hours. Upon completion of recruit school, a recruit holds the following certifications:

- Fire Fighter I and Fire Fighter II, according to NFPA 1001 *Standard for Fire Fighter Professional Qualifications*
- Hazardous Materials Awareness and Hazardous Materials Operations
- Weapons of Mass Destruction
- ICS 100, Introduction to the Incident Command System, and ICS 200, Basic Incident Command System
- National Incident Management System (NIMS) IS700A, Introduction to the National Incident Management System

Upon completion of recruit fire training, the recruit is required to complete the Emergency Medical Technician-Basic, which is 150 hours (nine weeks). Once the recruit has successfully completed these curricula, the recruit becomes a probationary fire fighter, which consists of three rotations (4 months each) in three different companies (engine, truck, heavy rescue) on the same shift. At the end of the probation period, the probationary fire fighter must pass a 250-question written examination and a practical skills examination. After a fire fighter has completed probation, the fire fighter may take a year or more to enter the EMT—Paramedic certification program. This is a 52-week course that the fire fighter completes during days off (Monday–Friday).

Fire Fighter #1
The fire fighter had been a career fire fighter with more than 10 years of experience and had been employed by this career fire department less than a year. He had received the following certifications and training: Fire Fighter I and Fire Fighter II (NFPA 1001 *Standard for Fire Fighter Professional Qualifications*), Fire Inspector I (NFPA 1031 *Standard for Professional Qualifications for Fire Inspector and Plan Examiner*), Fire Investigator I (NFPA 1033 *Standard for Professional Qualifications for Fire Investigator*), Fire Instructor III (NFPA 1041 *Standard for Fire Service Instructor Professional Qualifications*), Fire Officer II (NFPA 1021 *Standard for Fire Officer Professional Qualifications*), EMT-Intermediate, Confine Space, Trench Rescue, Ice Rescue, and Rope Rescue.

Fire Fighter #2
The fire fighter had been a career fire fighter with more than 16 years with this fire department. He had received the following certifications and training: Fire Fighter I and Fire Fighter II (NFPA 1001 *Standard for Fire Fighter Professional Qualifications*), Fire Inspector I (NFPA 1031 *Standard for Professional Qualifications for Fire Inspector and Plan Examiner), EMT-B.*

Engine 3 Lieutenant
The lieutenant had more than 24 years of experience and had received the following certifications and training: Fire Fighter I and Fire Fighter II (NFPA 1001 *Standard for Fire Fighter Professional Qualifications*), Fire Inspector I (NFPA 1031 *Standard for Professional Qualifications for Fire Inspector and Plan Examiner*), EMT-Paramedic.

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Incident Commander
The battalion chief had more than 21 years of experience and had received the following certifications and training: Fire Fighter II (NFPA 1001 *Standard for Fire Fighter Professional Qualifications*), Fire Instructor III (NFPA 1041 *Standard for Fire Service Instructor Professional Qualifications*), Fire Officer (NFPA 1021 *Standard for Fire Officer Professional Qualifications*), and Hazardous Materials Operations.

Structure

The structure was built in 1877 as a mixed occupancy (commercial and residential occupancies) that consisted of a market, apartments, and garage. The structure was primarily Type III construction built on a concrete slab. The structure had a flat roof consisting of rough-sawn wooden rafters covered by tongue-and-groove wood planks under felt and tar. The structure had a two-story attachment consisting of a two-door garage with apartments on both floors (see Photo 1). The two-story attachment was added on later (date undetermined) and was Type V construction in the rear and on the second-floor. The front part of the garage was used by the owner of the building for storage. The rear of the first floor was an apartment. The second floor consisted of an apartment (see Diagrams 1, 2, and 3). Access to the second-floor apartment was by a wooden deck-type external stairway on Side Delta. On Side Charlie, an addition not permitted by the city, containing a first-floor apartment, was built that measured approximately 14 feet by 20 feet with a shed-type pitched roof that was attached to the original two-story structure at the roof line. The exterior was 2-inch by 4-inch dimensional lumber covered with foam board sheathing and vinyl siding. The interior was 2-inch by 4-inch dimensional lumber covered with drywall and no insulation. The fire was in the two-story attachment. This part of structure had a different address from the market address to which the response was dispatched.

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Photo 1. View of structure from Side Alpha. The first floor at the Alpha/Delta corner (to the right) was a small local market. The remainder of the structure is apartments, both first floor and second floor.
(Photo from Google Earth.)

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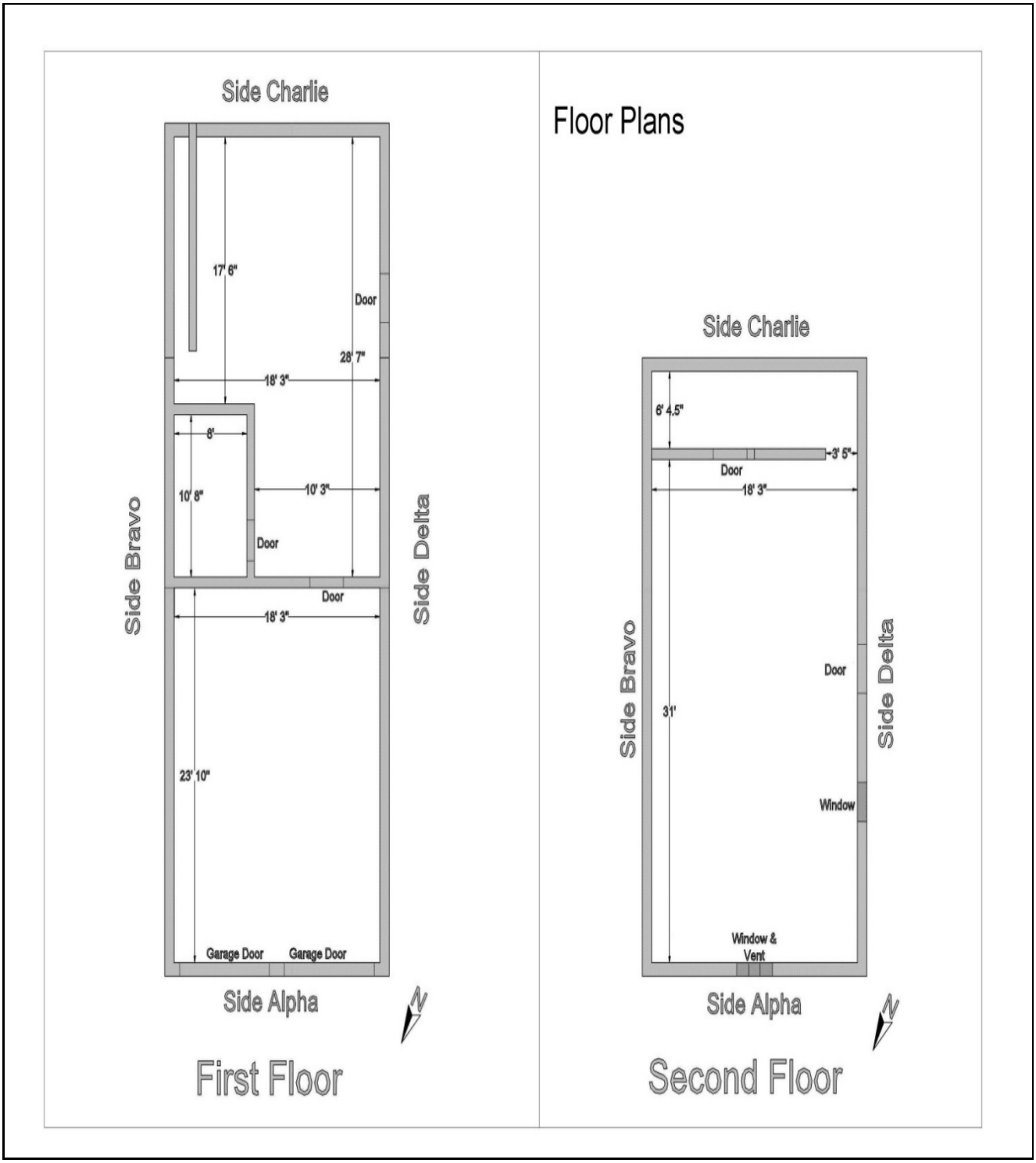

Diagram 1. Dimensional layout of the first and second floors of the fire structure.
(Diagram courtesy of the city's Engineering Services.)

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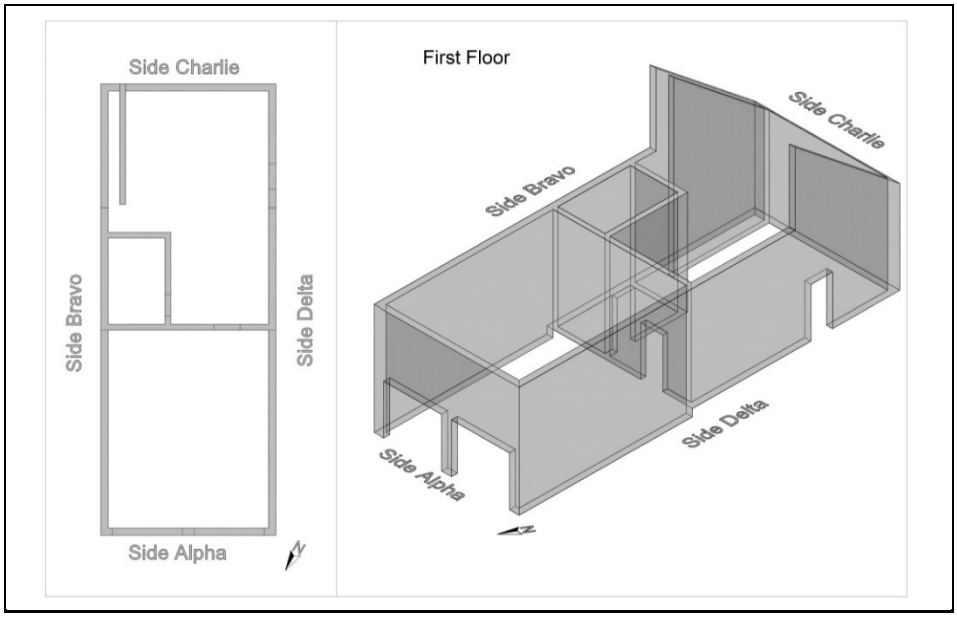

Diagram 2. First-floor three-dimensional view of the fire structure.
(Diagram courtesy of the city's Engineering Services.)

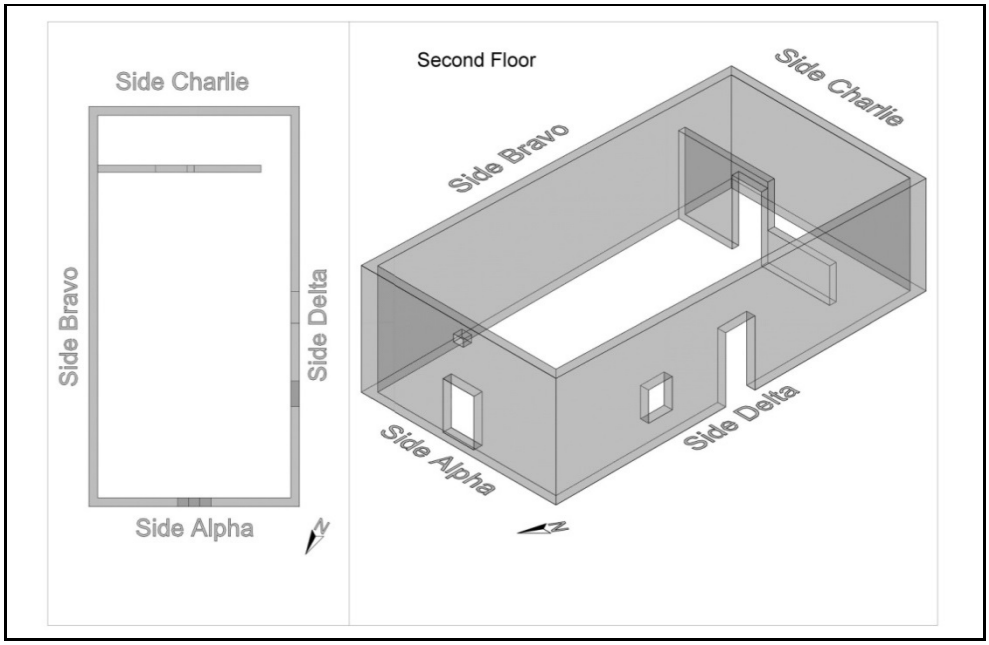

Diagram 3. Second-floor three-dimensional view of the fire structure.
(Diagram courtesy of the city's Engineering Services.)

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Equipment and Personnel

On January 26, 2014, the county dispatch center transmitted an alarm from a caller that reported her apartment was on fire with people still in the building. The units assigned were four engines, one truck, one rescue, and a battalion chief. *Note: Engine 3 is normally housed 0.2 miles from the incident; however, their station was closed for complete renovation. Engine 3 was temporarily housed at Fire Station 13, which was 1.4 miles away. In addition, on the day of the incident the most direct route to the incident required crossing a bridge, which was closed for repairs for months. The detour route added another 1.2 miles for a total of 2.6 miles from the incident.*

The table below identifies the apparatus and staff dispatched on the first-alarm assignment, along with their approximate dispatch time and on-scene arrival times (rounded to the nearest minute). *Note: When a company that houses an engine company and a rescue transport are dispatched to a structure fire, the dispatch is for both units. For companies with an engine and rescue transport or advance life squad unit, the staffing is an officer and two fire fighters on the engine and two fire fighters (EMT-Basic or EMT-Paramedic) on the rescue transport or life squad.*

Table. First-alarm Equipment and Personnel Dispatched

Resource Designation	Staffing	Dispatched (rounded to minute)	On-scene (rounded to minute)
Battalion Chief 1 (incident commander)	Battalion Chief	1447 hrs	1453 hrs
Engine 3	Officer, 2 fire fighters, and a probationary fire fighter	1447 hrs	1453 hrs
Engine 13	officer and 2 fire fighters	1447 hrs	1453 hrs
Rescue 13	2 probationary fire fighters	1447 hrs	1453 hrs
Engine 6 (Rescue 6 was out on a medical call, shorting the engine company their officer and a fire fighter)	acting officer and 2 probationary fire fighters	1447 hrs	1453 hrs
Engine 17	officer, fire fighter, and 2 probationary fire fighters	1447 hrs	1454 hrs
Truck 17	officer and 2 fire fighters	1447 hrs	1454 hrs

Engine 19 (supplemental crew for Engine 6)	officer (assigned as safety officer), fire fighter, and a probationary fire fighter	1449 hrs	1457 hrs
Resource Designation	**Staffing**	**Dispatched (rounded to minute)**	**On-scene (rounded to minute)**
Rescue 19	fire fighter and a probationary fire fighter	1458 hrs	1500 hrs

Timeline

An approximate timeline summarizing the significant events of the incident is listed below. The times are approximate and were obtained by studying available dispatch records, photos, run sheets, witness statements, and fire department records. The times are rounded to the nearest minute. The timeline is not intended, nor should it be used, as a formal record of events.

- **1447 Hours**
  Battalion Chief 1, Engine 3, Engine 13, Rescue 13, Engine 6, Engine 17, and Truck 17 are dispatched to a structure fire with people inside. *Note: A number of first-due companies were out of service when the alarm was dispatched for this incident. Engine 7, Squad 7, and Rescue/Transport 6 were on emergency medical incidents, and Engine 5 and Truck 5 were out of service due to rehab from a training exercise and weren't back filled.*

- **1449 Hours**
  Engine 19 is added to the alarm to supplement staffing as Rescue 6 was assigned to another incident.

- **1452 Hours**
  Battalion Chief 1 reports smoke showing from 2 blocks away.

- **1453 Hours**
  Engine 3 reports on location; Battalion Chief 1, Engine 13, Rescue 13, and Engine 6 arrive on scene; Battalion Chief 1 takes command and assigns Engine 3 as Fire Attack.

- **1454 Hours**
  Engine 17 and Truck 17 arrive on scene; Battalion Chief 1 reports a 2-story ordinary frame construction with fire on Division 2; Command assigns Engine 6 as Fire Attack in the alley (Side Charlie/Delta).

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- **1455 Hours**
  Command assigns Engine 17 as the rapid intervention team (RIT). Truck 17 is ordered to "open up" the roof. *Note: Per department protocol, the third-due engine company is assigned as RIT. At this incident, Command changed the RIT assignment from Engine 6 to Engine 17. Engine 6 was riding without an officer, who was assigned to Rescue 6, which was assigned to a separate EMS incident.*

- **1456 Hours**
  Engine 13 is assigned as Search with Rescue 13 as back up.

- **1457 Hours**
  A building occupant informs Command that everyone is out of their apartment. Engine 19 arrives on scene.

- **1459 Hours**
  Command assigns the Engine 19 Officer as the safety officer.

- **1500 Hours**
  Engine 6 is at the apartment door on Division 2 with a 1¾-inch hoseline and sees another crew on Division 2; Engine 3 crew requests that the 1¾-inch hoseline be charged. Rescue 19 arrives on scene to join Engine 19.

- **1501 Hours**
  Command is informed there is fire on Division 1 and requests Engine 6 to check for extension on Division 2; Engine 6 gets water on the fire and reports heavy smoke and fire just inside the second-floor apartment door.

- **1502 Hours**
  Engine 3 crew member's mic keys but no transmission. Engine 19 is ordered to lay a supply to Engine 6. Engine 17 Officer reports RIT size-up. Command requests Truck 17 to vent the roof of the apartment.

- **1503 Hours**
  Battalion Chief 3 arrives on Side Charlie and reports heavy fire on the rear addition. Engine 6 taking heavy smoke on the second-floor landing; Engine 3 Fire Fighter (FF#1) calls a Mayday; the Engine 3 Officer rolls out the second-floor apartment door onto the landing and calls a Mayday; Command orders an evacuation.

- **1504 Hours**
  Command notifies Dispatch and calls for emergency traffic. Command tries calling Engine 3 to confirm the Maydays. Engine 7 and Squad 7 are added to the incident.

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- **1505 Hours**
  Battalion Chief 3 confirms two fire fighters from Engine 3 are still inside on Division 2 and were supposedly headed toward Side Charlie.

- **1506 Hours**
  Engine 3 Officer confirms two fire fighters from Engine 3 are still missing. Command assigns Battalion Chief 3 as "Operations" while Command manages the Mayday.

- **1508 Hours**
  Command requests Engine 17 RIT go inside the second-floor apartment.

- **1509 Hours**
  Command assigns Engine 7 to assist RIT.

- **1510 Hours**
  Rescue 19 and Squad 7 arrive on scene. Truck 17 reports that they can't ventilate the roof due to the heavy smoke conditions.

- **1511 Hours**
  Engine 7 makes entry through a Side Alpha window on Division 2 and requests minimal radio traffic due to all the noise. Engine 7 reports heavy heat conditions on the second floor.

- **1513 Hours**
  Engine 17 RIT made entry on Side D Division 2.

- **1514 Hours**
  Battalion Chief 3 reports that most of the fire in the rear (Side Charlie) is knocked down.

- **1516 Hours**
  Squad 7 on Division 1 has knocked down fire in the rear and is searching for fire fighters.

- **1517 Hours**
  Engine 7 finds Fire Fighter #1 on Division 2 near Alpha/Bravo corner.

- **1519 Hours**
  Engine 7 brings Fire Fighter #1 out Side Delta, Division 2 door to Life Squad 1.

- **1521 Hours**
  Engine 17 RIT is out of the building getting new air bottles. Command assigns Engine 19 as RIT and to assist Engine 17.

- **1524 Hours**
  Squad 7 reports most of the fire knocked down and a ceiling collapse on Division 1 in the rear (Side Charlie).

- **1527 Hours**
  Engine 7 located Fire Fighter #2 on Division 2 and is being brought out the Side Delta door.

- **1528 Hours**
  Command calls for a personnel accountability report for all units.

Personal Protective Equipment

Both fire fighters were wearing a work station uniform, turnout coat and pants, gloves, hood, boots, helmet, self-contained breathing apparatus (SCBA) with an integrated personal alert safety system (PASS), and a portable radio. At the time of the investigation, the personal protective equipment (PPE) was in the custody of the city's police department. NIOSH investigators were able to gain access to all PPE for the purpose of inspection and documentation. All turnout gear inspected met NPFA 1971 *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.[1] Primarily, Fire Fighter #1 had new 2013 edition PPE and Fire Fighter #2 had 2003 edition PPE.

The victims' SCBAs were evaluated by the NIOSH National Personal Protective Technology Laboratory and a summary report is enclosed as Appendix I. The evaluation showed no evidence that the performance of the SCBAs was a contributing factor in the 2 fatalities. The full report is available upon request.

Weather Conditions

According to data from the Weather Underground, the sky conditions were overcast with 10-mile visibility. The temperature was 22 degrees F. Dew point was 12 degrees F. Relative humidity was 66%. Wind speed was 13 mph and wind direction was SSW. Barometric pressure was 29.47.[2] *Note: The wind may have contributed to the fire growth once crews opened the first and second floor apartment doors to attack the fire thereby creating additional ventilation openings.*

Investigation

On January 26, 2014, a 42-year-old male career fire fighter/EMT-B and a 31-year-old male career fire fighter/EMT-B died in a two-story attached garage apartment (see Photo 1). Engine 3, Engine 13, Rescue 13, Engine 6, Engine 17, Truck 17, and Battalion Chief 1 were dispatched to a structure fire with reported people inside the building. Battalion Chief 1 reported smoke showing 2 blocks away and indicated a "working fire" as he drove by on Side Delta. Engine 3 was first on scene, followed by Engine 13. Engine 3 pulled up in front of the attached garage apartment. The driver/operator of Engine 13 hand stretched a 5-inch supply line about 200 feet to Engine 3 from the intersection west of the structure. Battalion Chief 1 parked his vehicle at the intersection and walked east to the front of the building. Battalion Chief 1 assumed command and gave an updated address to the attached garage with an apartment above. Smoke was showing from the garage apartment that was structurally attached to the initial reported address. Command assigned Engine 3 as Fire Attack on Side Alpha. Engine 6 was dispatched as the third-due engine. Per department policy, Engine 6 would be the rapid intervention team (RIT); however, because Engine 6 arrived with an acting officer and two probationary fire fighters, Command re-assigned Engine 6 as Fire Attack on Side Charlie. Engine 17 was re-assigned as RIT. Truck 17 pulled past Engine 3 in the front and was assigned to "open up" the roof. Engine 13 was

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assigned search with Rescue 13 (see Diagram 4). *Note: Command was informed by an occupant at the scene that all occupants were out of their apartment but there was a dog on the second floor.* Engine 13 opened a first-floor Side Alpha apartment man-door on the Delta exposure of the garage.

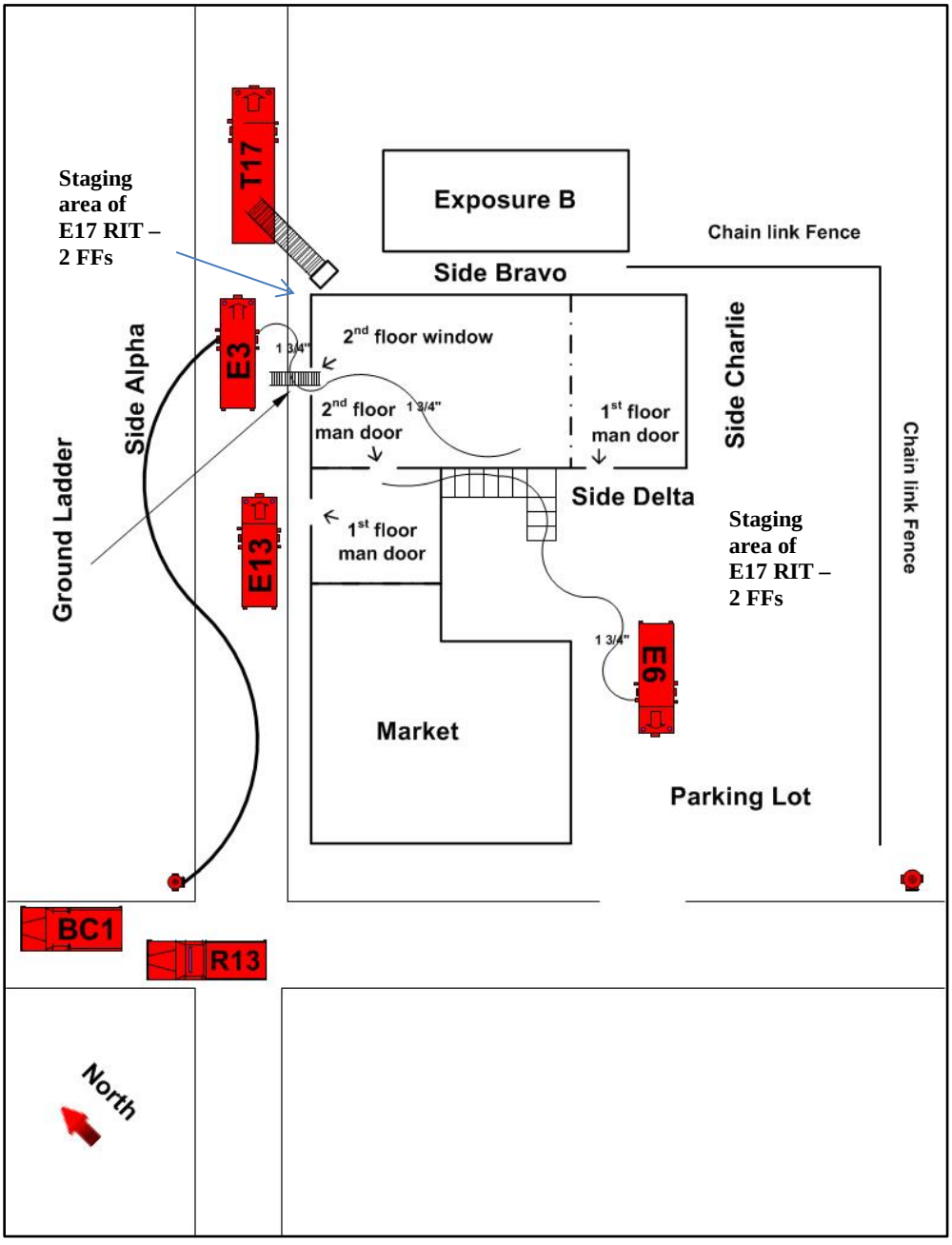

Diagram 4. Initial apparatus placement and hoseline deployment of the first alarm companies.

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Photo 2. Side Alpha of the structure. Engine 3 entered the second-floor window upon arrival. Engine 13 opened the left garage door to initiate the initial search.
(NIOSH photo)

The apartment appeared to be vacant and provided no access to the fire building. There appeared to be no access to the second-floor apartment via Side Alpha, so Engine 3 placed a ground ladder to a second-floor window, above the garage. Engine 3 took out the window and light gray smoke vented from the window (see Photo 2). The officer from Engine 13 tried to open the right garage door but it was locked. He tried the garage door on the left and it opened. Rescue 13 pulled a 1¾-inch hoseline from Engine 3 and took a position in front of the open garage door. The officer of Engine 13 directed them to keep fire out of the garage. The officer and fire fighter from Engine 6 pulled a 1¾-inch hoseline from Engine 6 and went to a second-floor man-door on Side Delta to check for fire extension (see Photo 3). Engine 17 split into two teams and went to diagonal corners (A/B and C/D) to do their 360 size-up and observe changing conditions. The RIT officer maintains constant communications with Command regarding the RIT operations.

Truck 17 had positioned the tower ladder to get on the roof to initiate roof ventilation. Engine 3 pulled

another 1¾-inch hoseline and stretched it up the ground ladder. At approximately 1458 hours, the officer and two fire fighters from Engine 3 made entry through the second-floor window on Side Alpha with the uncharged hoseline. The Engine 13 officer stretched the 1¾-inch hoseline that Rescue 13 had been operating up the ladder to use as a back-up hoseline at the window.

Photo 3. Exterior stairs to Side Delta man-door to second-floor apartment that Engine 6 entered.
(NIOSH Photo)

The acting officer and fire fighter from Engine 6 made entry into the second-floor apartment. Once inside the doorway, Engine 6 turned to the right along the Side Delta wall just as the two fire fighters from Engine 3 went by them. The Engine 6 crew went along the Side Delta wall about 8–10 feet. They stated they didn't feel much heat but visibility was zero. The Engine 6 acting officer held on to the fire

fighter's SCBA straps to keep them from losing contact. At approximately 1501 hours, the Engine 3 officer called for their hoseline to be charged. The Engine 3 officer moved toward his crew on the nozzle and noticed a sliver of light coming from a doorway on his right. Approximately 30 seconds later, the Engine 6 acting officer called for water. The Engine 6 fire fighter opened the nozzle and penciled the ceiling and Side Charlie wall. The Engine 6 crew felt extreme heat and encountered heavy, black smoke. About the same time, the Engine 3 officer noticed fire rolling over his head. The Engine 3 fire fighter (Fire Fighter #1) opened the nozzle and directed the stream toward the ceiling. They experienced extreme heat and heavy, black smoke came down on them. The Engine 3 officer told his crew, "I got a door." At 1502 hours, the Engine 3 back-up man's (Fire Fighter #2's) portable radio "keyed up" but there was no transmission.

At 1502 hours, Command ordered Engine 19 to supply Engine 6 with water. Engine 17 reported they had completed their size-up and RIT was ready with egresses to the second floor via Side Alpha and Side Delta. "Command" again requested Truck 17 to get the roof ventilated. At approximately 1503 hours, Battalion Chief 3 arrived in the rear. Battalion Chief 3 noticed Engine 6 was out of water and had not established a permanent water supply. Battalion Chief 3 reported to Command that Side Charlie was fully involved. Engine 3 was at the second floor by the Side Delta man-door when heavy, black smoke came pouring out of the apartment. Smoke conditions changed so quickly that Truck 17 couldn't see to get on the roof. Battalion Chief 3 informed Command that Engine 6 needed to be pulled out of the apartment. Battalion Chief 3 advised Command that another hoseline was being pulled off Engine 6.

At 1503 hours, Fire Fighter #1 (Engine 3) transmitted a Mayday, then 10 seconds later the Engine 3 officer called another Mayday. The Engine 3 officer then came out the second-floor doorway by Engine 6. Command transmitted an order to evacuate the structure. The Engine 13 officer was at the Side Alpha window on the ground ladder with the back-up hoseline and heard a small explosion. He tried to look through the window and call out to the Engine 3 crew, but the extreme heat forced him off the ladder. He noticed that a black substance had splattered his facepiece. At 1504 hours, the Engine 13 officer transmitted to the Engine 3 crew to evacuate the structure.

The Engine 3 officer, who had just escaped the flashed over second-floor apartment onto a small exterior deck, removed his facepiece and transmitted another Mayday. He grabbed Engine 3's hoseline that was near the apartment door and proceeded to pull and tug on it hoping to guide the two Engine 3 fire fighters toward the door. Less than a minute later, Fire Fighter #1 transmitted another Mayday. The safety officer (officer from Engine 19) had seen the Engine 3 officer exit the structure and went to assist him. The safety officer and a fire fighter from Engine 17 then attempted to enter the man-door on Side Delta, but the extreme heat kept driving them out of the apartment. The safety officer had crawled in about 5 feet toward the C/D corner before being driven back. It was observed later that the safety officer's gear had turned reddish orange from extreme heat exposure, thus comprising the integrity of the turnout gear. Command and Dispatch tried to maintain radio contact with the fire fighters but received no further responses.

At approximately 1507 hours, Command assigned Battalion Chief 3 to manage Operations while he managed the Mayday and monitored the RIT operation. Command requested Battalion Chief 3 to get

water on Side Charlie to prevent the fire from getting to the Side B exposure. Battalion Chief 3 responded affirmative as soon as Engine 6 has a permanent water supply. At approximately 1510 hours, Engine 19 established a water supply to Engine 6. Engine 6 put a 2½-inch hoseline into operation on Side Charlie. Rescue 19 and Squad 7 arrived on scene. Truck 17 informed Command they could not make the roof due to the smoke conditions. Command then announced that the fireground strategy was being switched to defensive operations.

Engine 7 had been monitoring the incident while on an emergency medical incident. They heard the Mayday and prompted Dispatch to add them to the incident. Engine 7 arrived on scene at 1509 and was assigned to assist the Engine 17 RIT in rescuing the two fire fighters from Engine 3. Engine 7 entered the structure through the Side Alpha window and requested emergency traffic only. Engine 7 reported extreme heat conditions in the apartment. At approximately 1513 hours, the safety officer and the Engine 6 fire fighter took a charged 1¾-inch hoseline into the second-floor apartment on Side Delta with the Engine 17 RIT behind them. Squad 7 was assigned fire attack on the first floor and was fighting fire on the first floor toward Side Charlie. A minute or two later, Battalion Chief 3 reported to Command that the majority of the fire was knocked down while crews continued to search for the two missing fire fighters.

At approximately 1517 hours, Engine 7 notified Command that they had found a downed fire fighter (Fire Fighter #1). They exited the Side Delta man-door carrying the fire fighter down the stairs to Life Squad 1 in the rear parking lot. The Engine 7 and Engine 17 RITs re-entered the second floor to continue searching for Fire Fighter #2.

At approximately 1521 hours, both Engine 7 and Engine 17 RITs exited the structure to change air cylinders. The incident commander assigned Engine 19 as RIT. As Engine 19 entered to search, they were accompanied by their captain (the safety officer). Battalion Chief 3 informed Engine 19 the first fire fighter was located in the A/B corner of Division 2. Squad 7 continued to knock down fire and search on Division 1 as they advanced to the rear.

Several minutes later, Squad 7 reported a ceiling collapse near the C/D corner, alerting the crews on Division 2 to the hazard. Fire Fighter #1 was transported to the hospital at this time. The Engine 7 RIT re-entered the structure through the Side Alpha window to continue the search. At approximately 1527 hours, the Engine 17 RIT re-entered on Side Delta, and within seconds, the Engine 7 RIT located the second fire fighter near the center of the room toward the rear (See Diagram 5). Fire Fighter #2 was brought out the same way as the first fire fighter and was transported to the hospital by a private advanced life support (ALS) unit. Both fire fighters received advance life support but died from their injuries. At approximately 1528 hours, a personnel accountability report was completed for all fire fighters on the scene.

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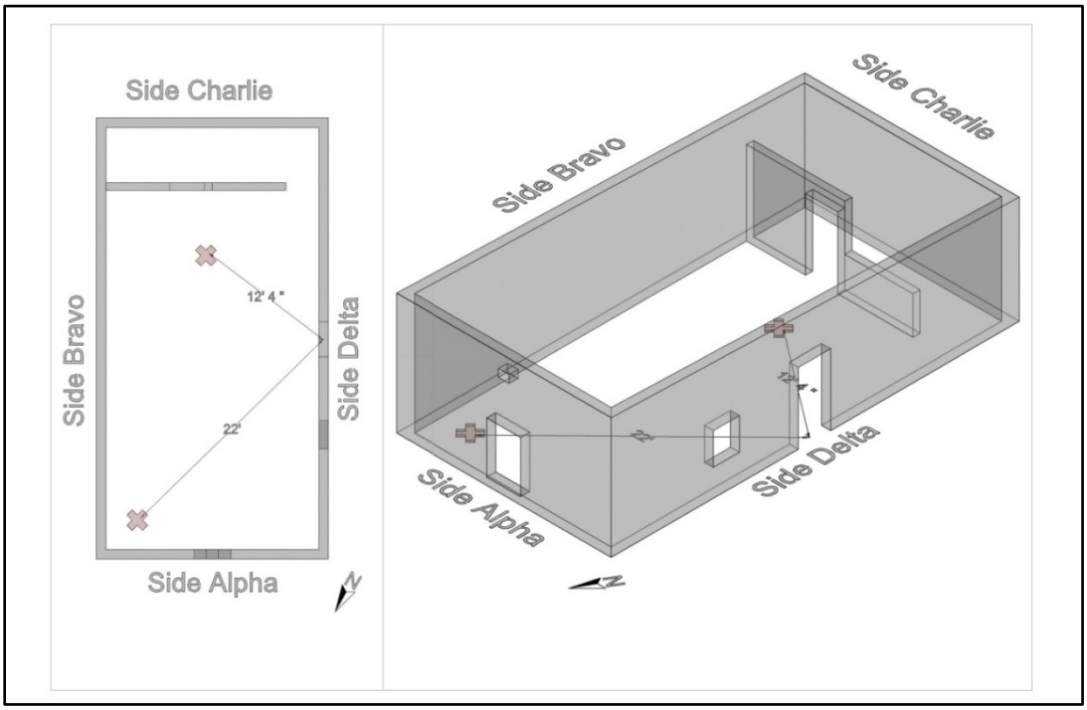

Diagram 5. Approximate locations of the two fallen fire fighters on the second floor of the fire structure. Fire fighter #1, which was located first, was found near the Alpha/Bravo corner. Fire fighter #2 was found closest to the Side Delta man door. (*Diagram courtesy of the city's Engineering Services.*)

Fire Behavior

According to the state fire marshal and investigating insurance agency, the fire was intentionally set in the rear of the garage storage area along the wall common to the garage and rear apartment.

Indicators of significant fire behavior

- Smoke on Side Charlie upon arrival
- Heat and heavy black smoke on second floor
- Heavy fire on Side Charlie, both first and second floors
- Fire under control approximately 31 minutes after arrival

Contributing Factors

Occupational injuries and fatalities are often the result of one or more contributing factors or key events in a larger sequence of events that ultimately result in the injury or fatality. NIOSH investigators identified the following items as key contributing factors in this incident that led to the fatalities:

- Arson

- Resource deployment
- Risk assessment and scene size-up
- Resource deployment
- Fireground tactics
- Inadequate water supply
- Crew staffing
- No full-time safety officer
- No sprinkler system in the building

Cause of Death

According to the county coroner's report, the cause of death for both fire fighters was thermal burns and exposure to carbon monoxide. Fire Fighter #1 had a carbon monoxide level of 16.7% and Fire Fighter #2's was 38.5%. The Engine 3 officer sustained burns to his left wrist, left cheek, and left ear.

Recommendations

Recommendation #1: Fire departments should ensure that the incident commander conducts an initial 360-degree size-up and risk assessment of the incident scene to determine if interior fire-fighting operations are warranted.

Discussion: Size-up involves gathering information and evaluating fireground factors, which are then used to determine the amount of involvement that fire fighters will need to bring the situation under control. The risk that fire fighters will face must be weighed against the potential to save lives and property. Today's modern fire environment demands a more thorough and accurate size-up. Lightweight construction and modern furnishings cause faster fire propagation, quicker time to flashover, shorter time to collapse, and reduced escape times for fire fighters and occupants. The fireground can be unforgiving; there is little room for error. Fire fighters must evaluate three factors at every incident: building construction, smoke conditions, and the survivability profile of potential occupants.[3]

A proper size-up begins from the moment the alarm is received and it continues until the fire is under control. The on-scene size-up should include an evaluation of factors such as the fire size and location, access or barriers, length of time the fire has been burning, conditions on arrival, occupancy type, building construction and floor plan of the structure, fuel load and presence of combustible or hazardous materials, exposures, time of day, available staffing on scene or enroute, and weather conditions. Information on the structure itself should include size, construction type, age, condition (e.g., evidence of deterioration, weathering), renovations, lightweight construction, loads on roof and walls (e.g., the presence of air conditioning units, ventilation ductwork, utility entrances), and available preplan information—all key information that will allow the first arriving officer to accurately determine the correct strategy to be employed. The size-up should also include a continuous risk-versus-gain assessment, especially when benchmarks (e.g., primary search complete, fire knocked down) are met.[4–9]

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NFPA 1500 *Standard on Fire Department Occupational Safety and Health Program*, section 8.3, provides detailed information regarding the risk management during emergency operations.[10] The strategy and tactics of an incident are dictated by the size-up, initial risk assessment, and situational report by the first arriving officer. If physical barriers make the 360-degree size-up impractical for the first arriving officer, the size-up of Side Charlie may be delegated to another engine company or truck company. However, **unless an obvious life safety issue exists (e.g., visible victims requiring immediate assistance)**, interior fire-fighting operations should not be considered until a report from Side Charlie is received and an interior attack is warranted. A radio report of conditions, including those on Side Charlie, should be transmitted over the assigned tactical channel to the incident commander and the dispatch center. The transmission should include the following:

- Civilian lives at risk. This information is critical to letting the responders know if they need to assume an aggressive attack to save lives from the start or whether they have time to develop a safer, more defensive strategy.
- Smoke and fire conditions, with an emphasis on identifying the seat of the fire. The initial radio report from the first arriving unit for a structural fire should include the signal for a working fire, the number of stories, type of occupancy, and location of the fire. This information lays the foundation for additional reports and serves as notification to responding units as to type of SOPs to implement.
- Building description. If available, this information would aid in implementing or adjusting SOPs or planning necessary alternative actions.
- Building features; e.g., number of stories, particularly if there is a difference between sides Alpha and Charlie.
- Basement access.
- Any other safety hazards.

Any change to operational priorities or responsibilities based on the above size-up shall be clearly communicated to Command, all responding units, and the dispatch center via the assigned tactical radio channel.[3, 11]

Even before taking command of an incident, an officer must determine what strategy and tactics will have to be deployed to bring the incident under control. The necessary tasks that need to occur at any fire regardless of the occupancy are an initial on scene report upon arrival, initial risk assessment, situational report, location of water supply, deployment of hoselines and back-up hoselines, search and rescue, ventilation, initial rapid intervention crews, ground and aerial ladder placement, fire attack and extinguishment, and salvage and overhaul. Over the past few years, fire fighters have adopted an acronym that details the steps to take when confronted with a fire: *SLICERS*.

- **S**ize up all scenes.
- **L**ocate the fire.
- **I**dentify and control the flow path (if possible).

- **C**ool the heated space from a safe location.
- **E**xtinguish the fire.
- **R**escue and **S**alvage, which are actions of opportunity that may occur at any time.[12]

The fire was assumed to be on the second floor due to smoke coming out the Side Delta door. The initial arriving engine company and battalion chief and command proceeded to Side Alpha. The battalion chief drove past Side Charlie and Side Delta when he arrived on scene. Engine 6 backed into the parking lot on Side Charlie but did not reported any fire showing from Side Charlie or Side Delta. It was clear early on that no one was in the burning structure, allowing more time to complete the size-up before initiating interior fire-fighting activities. *Note: No occupants were found in the structure and a dog was later recovered.* A thorough size-up of the Side Delta first floor may have indicated that the fire originated on the first floor and the Side Delta man-doors would have been an option for initial entry for both the first and second floors.

Recommendation #2: Fire departments should integrate current fire behavior research findings developed by the National Institute of Standards and Technology (NIST) and Underwriter's Laboratories (UL) into operational procedures by developing standard operating procedures, conducting live fire training, and revising fireground tactics.

Discussion: The National Institute of Standards and Technology (NIST) and Underwriters Laboratories (UL) have conducted a series of live burn experiments designed to replicate conditions in modern homes and residential structures and to validate previous testing done in laboratory settings. The results of these experiments will enable fire fighters to better predict and react to effects of new materials and construction on fire. The fire research experiments were conducted in cooperation with the Fire Department of New York, Chicago Fire Department, Spartanburg South Carolina Fire and Rescue, and other agencies. The live burn tests are aimed at quantifying emerging theories about how fires are different today, largely due to new building construction and the composition of home furnishings and products. In the past, these products were mainly composed of natural materials, such as wood and cotton, but now contain large quantities of petroleum-based products and synthetic materials that burn faster and hotter and also generate large volumes of fuel-rich smoke. Where a fire in a room once took approximately 20 minutes to flashover—igniting all the contents—this can happen with today's products in as little as 4 to 5 minutes.[8]

In addition, modern living spaces tend to be more open, less compartmentalized and are better insulated than homes built years ago. As a result, interior residential fires can generate oxygen-depleted, fuel-rich environment within minutes. This fire condition of hot, fuel-rich smoke is highly reactive to the introduction of oxygen. Introducing oxygen to this environment by opening a door or venting a window may result in a rapid transition to flashover. These same conditions can occur in commercial structures as seen in the fire at the Charleston, South Carolina, Sofa Super Store.[9]

The NIST and UL experiments evaluated individual and combinations of methods for strategically ventilating and isolating fires to prevent flashover—or at least delay it. In contrast, kicking a door open or breaking a window without knowledge of conditions inside could create a portal for air that can literally fan the flames by introducing oxygen into an oxygen-limited fire environment.

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Traditionally, fire suppression operations were conducted from the interior of the structure as a means to reduce water damage and limit fire damage to structures. These operations must be coordinated with the ventilation operations. Previous research and examinations of line-of-duty deaths have shown that ventilation events occurring with fire fighters in the structure prior to suppression have led to tragic results.[9, 13, 14] One means of eliminating the possibilities of this occurrence would be a transitional attack, in which water is directed into the structure from the exterior to cool the fire gases and reduce the heat release rate of the fire, prior to the fire fighters entering the building. The major concern with this type of operation is the potential harm that might occur to people trapped in the structure or the amount of water damage to the structure. Therefore, measurements are needed to document the changes of the thermal environment within the structure and the impact on the viability of people who might be trapped in the structure.[8]

Based upon the NIST and UL research, the following fireground operations should be considered for implementing the following:

- *Size-Up*
  Size-up must occur at every fire. Consideration must be given to the resources available and situational conditions, such as weather, fire location, size of the fire and building, and the construction features. Ensure a 360-degree size-up is conducted whenever possible. A tactical plan for each fire must be developed, communicated, and implemented.
- *Ventilation*
  Fire departments should manage and control the openings to the structure to limit fire growth and spread and to control the flow path of inlet air and fire gases during tactical operations. All ventilation must be coordinated with suppression activities. Uncontrolled ventilation allows additional oxygen into the structure, which may result in a rapid increase in the fire development and increased risk to fire fighters due to increased heat release rates within the flow path.
- *Fire-fighting Operations*
  Given the fuel-rich environment that the fire service operates in today, water should be applied to the fire as soon as possible. In many cases, water application through an exterior opening into a fire compartment may be the best first action, prior to committing firefighting resources to the interior.

  Fire departments should cool the interior spaces of a fire building with water from the safest location possible, prior to committing personnel into spaces with, or adjacent to, fully developed or smoldering (ventilation limited) fire conditions.
- *Rapid Intervention*
  Fire department rapid intervention procedures should be updated to provide water on the fire as soon as possible and ventilation openings controlled during fire fighter Mayday incidents.[15]

Recommendation #3: Fire departments should ensure all fireground ventilation is coordinated with fire-fighting operations.

Discussion: Fire departments should manage and control the openings to the structure to limit fire growth and spread and to control the flow path of inlet air and fire gases during tactical operations. All ventilation must be coordinated with suppression activities. Uncontrolled ventilation allows additional

oxygen into the structure, which may result in a rapid increase in the fire development and increased risk to fire fighters due to increased heat release rates within the flow path. Underwriters Laboratories (UL) released a report on the *Impact of Ventilation on Fire Behavior in Legacy and Residential Construction*. This report addressed multiple ventilation locations and the possibility of creating fuel-limited fires. The research indicated it was not possible to create fuel-limited fires with multiple ventilation openings. The report stated, "It is more likely that the fire will respond faster because the already open ventilation location is allowing the fire to maintain a higher temperature than if everything was closed."[16]

The flow path of a fire is how a fire moves through the structure as determined by incoming and outgoing vents for air, since air allows fire to sustain or grow.[16] Identifying and controlling the flow path is about knowing where the air comes from and where it's headed, and its importance cannot be underestimated. The identification of flow path is an item that should find its way into every after-action review. To ensure the safety of the fire fighters, it is important that fire fighters be in a safe location while trying to locate the fire that is cooling the heated space. Once the fire is under control, the fire can be completely extinguished. The rescue and salvage operations are self-explanatory—if anything can be saved, save it. These two actions are always active, right from sizing up to extinguishing.[15]

The UL research was conducted on one-story and two-story houses. The data collected from this research project provides valuable insight into the impact of ventilation on fire behavior in both legacy and contemporary residential construction.[16] Based upon the UL research, the following are tactical considerations that should be considered during fireground operations:

- **Stages of fire development**: The stages of fire development change when a fire becomes ventilation limited. It is common with today's fire environment to have a decay period prior to flashover, which emphasizes the importance of a ventilation strategy.
- **Forcing the front door is ventilation**: Forcing entry has to be thought of as ventilation as well. While forcing entry is necessary to fighting a fire, it also adds another vent that feeds air to the fire. When this happens, the clock is ticking before either the fire gets extinguished or it grows until an untenable condition exists, jeopardizing the safety of everyone in the structure.
- **Flow paths:** Every new ventilation opening provides a new flow path for the fire. This could create very dangerous conditions when there is a ventilation-limited fire.
- **No smoke showing:** During the UL experiments, a common event was that once the fire became ventilation-limited, the smoke being forced out of the gaps of the houses greatly diminished or stopped all together. No smoke showing during size-up should increase awareness of the potential conditions inside.
- **Coordination:** If you add air to the fire and don't apply water in the appropriate time frame, the fire gets larger and safety decreases. A clear and direct communication between companies or crews assigned to ventilation, fire attack, and other tactical functions that take place inside the structure are required.

- **Smoke tunneling and rapid air movement through the front door:** Once the front door is opened, attention should be given to the flow of air through the front door. A rapid inrush of air, or tunneling effect, could indicate a ventilation-limited fire.
- **Vent Enter Search (VES):** During a VES operation, primary importance should be given to closing the door to the room. This eliminates the impact of the open vent and increases tenability for potential occupants and firefighters while the smoke ventilates from the now isolated room.[16]

At this incident, the wind was greater than 10 mph, which is the threshold according to UL/NIST research for wind-driven fires, and was blowing directly on Side Delta into an open apartment door on Division 2. The officer of Engine 3 determined the window on Side Alpha provided the best access to the second-floor apartment. Command had directed Engine 6 to stretch a hoseline to the second-floor door on Side Delta. The officer from Engine 13 was directed to gain access to Division 1 through the garage doors. He was unable to open the right garage door but was able to open the left garage door. This created the second ventilation opening. Division 1 was the area of origin and the seat of the fire. The opening of the garage door allowed air to flow directly to the seat of the fire.

Shortly after the officer from Engine 13 opened the garage door, a fire fighter from Engine 3 climbed the ground ladder and knocked out the second-story window on Side Alpha. This created a third ventilation opening. Command assigned Engine 17 as RIT. The officer from Engine 17 positioned two fire fighters behind the structure at the Charlie/Delta corner. The officer from Engine 17 and his driver positioned themselves in front. The two fire fighters positioned at the Charlie/Delta corner of the structure noticed heavy, brown smoke and fire showing from the wooden addition. The fire fighters walked over to the door on Division 1 side Delta and opened it, thereby creating a fourth ventilation opening. The addition became heavily involved shortly after the apartment door on Division 1 was opened. Fourteen minutes had elapsed between the time of dispatch and the acting officer from Engine 6 reporting water on the fire.

Command should conduct a complete and thorough size-up at all fires to ensure that the location of the fire has been identified and communicated to all fire fighters on the scene. Once the fire location has been determined, the strategy and tactics can be addressed and communicated in order to control the incident in a safe and effective manner.

Recommendation #4: Fire departments should ensure that the incident commander establishes a stationary command post for effective incident management, which includes the use of a tactical worksheet, efficient fireground communications, and a personnel accountability system.

Discussion: NFPA 1561 *Standard on Emergency Services Incident Management System and Command Safety* §5.3.1 states, "The incident commander shall have overall authority for management of the incident." The incident commander must establish and maintain a command post outside of the structure in order to assign companies, delegate functions, and continually evaluate the risk versus gain of continued fire-fighting efforts.[17]

Command Safety provides the incident commander a foundation for effective and efficient management of Type IV and Type V incidents and ensures the highest level of safety for fire

department members at emergency incident scenes. This system defines requirements that the incident commander must meet during an incident, including the establishment of a stationary command post and utilization of a tactical worksheet, effective fireground communications, and a personnel accountability system.

When a chief officer (e.g., battalion chief, district chief) arrives on scene, the first steps are to assume command, announce the name of the incident (e.g., Main Street Command), and establish a stationary, exterior, and remote command position. Once command is established and an initial size-up has been done, the incident commander should continue command and control functions inside or at the rear of the vehicle, which should have a command board.[18]

In establishing a command post, the incident commander shall ensure the following (NFPA 1561, Chapter 8—Command Safety):

- The command post is located in or tied to a vehicle to establish presence and visibility.
- The command post includes radio capability to monitor and communicate with assigned dispatch, tactical command, and other designated emergency traffic channels for that incident.
- The location of the command post is communicated to the communications center.
- The incident commander, or designee, is always present at the command post.
- The command post should be located in the incident cold zone.[17]

In order to effectively command an incident, the incident commander must be in the most advantageous position possible. The best position is a fixed, visible, and accessible location at the command post. This can be accomplished by utilizing the incident commander's staff vehicle, a designated command vehicle, or fire apparatus. An acceptable alternative is utilizing the rear area of a sport utility vehicle or van-style vehicle. This method will provide the incident commander with an area that is quiet and free of distractions from which to command an incident. It is also vital for the incident commander to be able to hear all radio transmissions, especially from those operating on scene. The best way to accomplish this is through the use of a radio communication headset. This will enable the incident commander to be in the best position possible to hear critical radio transmissions. The incident command post also should be visible and recognizable. This can be accomplished by displaying a colored light, flag, banner, or other symbol to mark the location. Where special command post vehicles are used, such vehicles are usually marked with distinctive identification to make the command post recognizable.[17]

The tactical worksheet is a critical piece of equipment because it helps the incident commander organize tasks by providing reminders, prompts, and a convenient workspace for tracking companies and apparatus. It allows them to slow down during what could be a large, multi-alarm incident, although the worksheet can be used for fires big and small, as well as EMS incidents, to help develop proficiency and to record vital information that may help them make future operational decisions. By documenting the assignments of division/group officers and division/group resources, the incident commander creates a visual reference of the overall fireground organization and deployment.[19]

The tactical worksheet is also an excellent tool when the passing of command must occur. On the fireground, the officer taking over command can quickly check the worksheet and obtain a strong understanding of the initial deployment of resources, the need for additional apparatus and equipment, and the status of units in the staging area.

The advantages of using a tactical worksheet are:

- includes a location to quickly note individual assignments;
- provides prompts for the incident commander, such as time, air management, and strategy;
- provides tactical benchmarks, such as primary search complete, fire under control, and loss stopped;
- facilitates consistent, organized information;
- documents assignments and responsibility;
- expedites passing of command or support for the incident commander;
- provides resource status.[17]

Fire departments should have a communications standard operating procedure (SOP) coupled with an effective training program. These procedures include the use of clear text (specifically, no 10 codes, or other terms that may be unfamiliar to other responders), a separate radio channel for dispatch, and a separate tactical channel to be used during the incident. When a tactical-level management unit is implemented (division or group), a fire department should provide a dispatch channel, a command channel, and a tactical channel. A fire department should provide the necessary number of radio channels with multiple tactical channels, depending on the type of incident and the complexity of the incident.

Another element that is essential to the success of the personnel accountability system is effective fireground or incident scene communications. The function of resource accountability should be assigned to a member who is responsible for maintaining the location and status of all assigned resources at an incident, such as a chief's aide. This is separate from the role of the incident commander. The incident commander is responsible for the overall command and control of the incident. Due to the importance of responder safety, this function should be assigned to an accountability officer or resource status officer. A number of members could function in this role including a staff assistant, chief officer, apparatus driver/operator, or other responder. There are many means of accounting for resources. Components can include tactical worksheets, command boards, apparatus riding lists, company responder boards, electronic bar-coding systems, and so forth depending on whether equipment or personnel are being tracked. These components can be used in conjunction with one another to facilitate the tracking of responders by both location and function. The components of any resource accountability system should be modular and expand with the size and complexity of the incident.[17]

An incident commander cannot successfully manage all of these functions without the benefit of a tactical worksheet, personnel accountability system, and adequate communications. The intent of Command Safety is to provide the incident commander with a system that allows the systematic development of an incident and in an environment without distractions. Also, managing all these systems can quickly become overwhelming and create task saturation for the incident commander. A

staff assistant or chief's aide is another essential element of this process. (See Recommendation #5.)

At this incident, the incident commander arrived on scene, parked his vehicle, and walked to the front of the fire building. He managed the incident from the front of the building and with a portable radio. Without the benefit of a tactical worksheet and personnel accountability system, task saturation may become an issue for incident commanders once a Mayday is communicated.

Recommendation #5: Fire departments should provide chief officers with a staff assistant or chief's aide to support Command Safety.

Discussion: A chief's aide, staff assistant, or command incident technician is a position designed to assist an incident commander with various operational duties during emergency incidents. The chief's aide is an essential element for effective incident management. At an emergency incident, the staff assistant can assist with key functions, such as managing the tactical worksheet; maintaining personnel accountability of all members operating at the incident, resource status, and deployment location; monitoring radio communications on the dispatch, command, and fireground channels; controlling information flow by computer, fax, or telephone; and accessing reference material and pre-incident plans.[19]

The incident commander and members who are assigned a supervisory responsibility that involves three or more companies or crews under their command should have an additional person (staff aide) assigned to facilitate the tracking and accountability of the assigned companies or crews. One of the essential functions or responsibilities of a chief's aide is to manage the personnel accountability system, a vital component of the fire fighter safety process. Accountability on the fireground can be maintained in a variety of methods. The intent is to have a functional system that is designed to account and track personnel as they perform their fireground tasks. In the event of an emergency or Mayday, the chief's aide uses this system to provide a rapid accounting of all responders at the incident.

Chief Officers are required to respond quickly to emergency incidents. In their response, they have to be fully aware of heavy traffic conditions, construction detours, traffic signals, and other conditions. More importantly, the chief officer must also monitor and comprehend radio traffic to assess which companies are responding, develop a strategy for the incident based upon input from first-arriving officers, and develop and communicate an incident action plan that defines the strategy of the incident. A chief's aide can assist the battalion chief or chief officer in processing information without distraction and can complete the necessary tasks en route to the scene.[18]

Departments should consider the chief's aide to be an individual who has the experience and authority to conduct the required tasks. Other potential roles for the chief's aide include assisting with the initial size-up, completing a 360-degree size-up, coordinating progress reports from division/group officers, and many others. The aide position can be used as a training position to help facilitate officer development. There also are non-emergency functions for the chief's aide that are vital to the daily operations of the department. Some jurisdictions assign a chief's aide to command officers to perform daily administration functions such as position staffing and leave management.

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At this incident, the incident commander did not have the benefit of a staff assistant to manage the personnel accountability system and assist with communications and the tactical worksheet. This may result in task overload for incident commanders.

Recommendation #6: Fire departments should ensure that all companies are staffed with an officer on the fireground.

Discussion: The company officer is responsible for organization, management, leadership, accountability, and safety of the fire fighters assigned to the company. The duties and responsibilities of the company officer focus on the operations of the company during emergency incidents and non-emergency activities.

NFPA 1500 *Standard on Fire Department Occupational Safety and Health Program* defines a company as a group of members (1) under the direct supervision of an officer; (2) trained and equipped to perform assigned tasks; (3) usually organized and identified as engine companies, ladder (truck) companies, rescue companies, squad companies, or multi-functional companies (quint); (4) operating with one piece of fire apparatus (pumper, aerial fire apparatus, elevating platform, quint, rescue, squad, ambulance) except where multiple fire apparatus are assigned that are dispatched and arrive together (task force), continuously operate together, and are managed by a single company officer; or (5) arriving at the incident scene on fire apparatus.[10] NFPA 1710 *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments* defines a company officer as a supervisor of a crew/company of personnel. Moreover, each company shall be led by an officer who shall be considered a part of the company.[20] The rank structure could be either sergeant, lieutenant, or captain.

The company officer is responsible for the direct supervision of the members of the company. From an incident management standpoint, the company officer maintains the chain of command, unity of command, and an appropriate span of control. When a company arrives at an incident, the fire fighters assigned to the company report directly to the company officer (unity of command), who clarifies reporting protocol. This eliminates the confusion caused by conflicting or multiple orders. Additionally, this reduces the span of control of fire fighters reporting to Command.[21] Most importantly, the company officer can maintain accountability of the fire fighters assigned to the company. The company officer also serves as the focal point for company communications. Though each fire fighter should or has a portable radio, the company officer is the contact for company communications on the fireground unless otherwise specified.

Company officers determine, based upon conditions, the priority of the task-level functions for their company unless otherwise ordered by Command. The assignment of these task-level functions represents a standard strategy for tactical operations designed to improve the effectiveness and safety of all companies working together. Splitting companies into individual fire fighters without a company officer creates an issue with span of control, personnel accountability (freelancing), and unity of command. This is particularly problematic during the early stages of an incident. Without an assigned or designated company officer, it is much more difficult for the incident commander or tactical level management to account for the location and function of individual fire fighters.

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The fireground is a rapidly changing and continuously evolving scene that requires command staff to process visible and audible information to affect a positive outcome for occupants and responders. The incident commander and the company officers must be able to prioritize tasks, be proficient in task management, and recognize when task saturation or task overload occurs.[22] Quickly sizing-up an incident scene and developing the appropriate strategy and tactics are essential functions required of a company officer upon arrival. A company officer must have the necessary knowledge, skills, and abilities to make the proper decisions on the fireground. Experience is necessary for fire officers to maintain proficiency and feel comfortable using their skills and apply the knowledge they have learned. The company officer must possess the ability to recognize risks and hazards in relation to their own safety and for the safety of their fire fighters. This ability is perhaps the most important individual factor to successful risk management and can have a direct effect in managing task saturation.[21]

Changes in the modern fire environment have caused significantly dangerous alterations in fire dynamics and fire behavior. It is imperative to conduct a thorough size-up of the tactical area prior to the commencement of operations. Evaluate all fireground factors to determine the amount of fire fighter involvement necessary to bring the situation under control. The company officer must ensure that he/she has the necessary information to make effective and safe tactical decisions that lead to a successful outcome of the incident.[3]

Identifying and predicting fire behavior can be a challenge for experienced fire officers and fire fighters and even more difficult for a novice fire officer or fire fighter. While fire departments may have enough residential structure fire-fighting experience, the same tactics employed on fires at other structures—e.g., a multi-family or commercial structure—may not yield the same results. Different styles of construction—e.g., those with significantly larger floor space or very high ceilings with large void areas that conceal fire and products of combustion—make it harder to check the overhead and the fire may get behind the crews stretching in.

Company operations during a structure fire are critical in terms of providing an organized system of tasks that ensures a positive outcome and provides the safety of the members. The company officer ensures the proper placement of the apparatus upon arrival and communicates the task assignment to the crew and how they will accomplish their assignment. The company officer maintains communications with the incident commander or division/group supervisor. As the members of a company enter a hazardous environment together, the company officer ensures that crew integrity and accountability is maintained.

In this incident, two different engine companies were staffed with fire fighters assigned as acting company officers. Their experience in terms of fireground operations was minimal as the fire fighters had been primarily assigned to emergency medical services (EMS). Moreover, a third of the members assigned to the fire and rescue department's Field Operations Bureau had less than 2 years of job experience. Also, a company officer must spend 12 hours a tour on a rescue transport per the collective bargaining agreement.

Additional training and education in terms of knowledge, skills, abilities, and competencies need to be provided for fire fighters assigned as acting officers. Members that are selected to move up as a

company officer should demonstrate the necessary job tasks required to function as a company officer. These job tasks include non-emergency and emergency duties and responsibilities performed by a company officer. The senior fire fighter is mentored over a defined period of time by a senior company officer.

Recommendation #7: Fire departments should ensure that driver/pump operators are trained and certified to provide sufficient water supply and fire flow on the fireground.

Discussion: Successful fireground operations are dependent on an established water supply maintained throughout the incident. The driver/operator of a pumper has the responsibility to ensure that water is available upon arrival, usually from the booster tank, and then from an established water supply such as a hydrant.[23] An established water supply is essential to the safety of the fire fighters operating inside the immediately dangerous to life and health (IDLH) environment. Establishing adequate water supply on the fireground is one of the most critical elements of firefighting. It is important in localities with a water distribution system and even more critical in areas where water must be transported from other locations.

The driver/operator, engineer, or motor pump operator is the individual responsible for ensuring that a water supply is established and water for extinguishment is provided. The position of driver/operator may be a promotional position or one that is a responsibility assigned to the duties and functions of a qualified fire fighter or senior fire fighter. NFPA 1002 *Standard for Fire Apparatus Driver/Operator Professional Qualifications* sets the minimum qualifications for driver/operators pumper.[24] The qualities and skill sets needed by a driver/operator include an understanding of different types of pumping apparatus, proper apparatus placement, location of available water supplies, proper pump discharge pressures for various types of attack hose, hydraulic calculations, and water supply choices. Prior to being promoted or assigned as a driver/operator pumper, the individual must meet the requirements of NFPA 1001 *Standard for Fire Fighter Professional Qualifications*, Fire Fighter I and Fire Fighter II[25] and should be certified to NFPA 1451 *Standard for a Fire and Emergency Service Vehicle Operations Training Program*.[26] A fire fighter must have the experience as a fire fighter before moving on to the position of driver/operator pumper or driver/operator aerial. It is crucial that the fire fighter has obtained the necessary knowledge, skills, abilities, and competencies of a fire fighter before moving forward as a driver/operator. The position of driver operator is more than just pumping a fire engine. The position involves driving an assigned fire apparatus to and from fires and other emergencies; determining an appropriate route for timely response; maintaining knowledge of road closures, out-of-service hydrants, and construction activities that would delay arrival; operating pumps and other mechanical equipment; participating in laying and connecting hoses; and establishing and controlling the pressure of water flow through various attack hoses.[27]

When driver operators are tasked with providing water for an attack hose, they need to ensure that a water supply is established in a very short period of time. The driver operator needs to also ensure that the proper fire flow and the correct amount of pressure are provided. It is even more critical if two hoselines are deployed. As part of the probationary curriculum, the fire and rescue department provides a pump operators course that covers the basics of driver/operator pumper but does not meet the requirements of NFPA 1002 *Standard for Fire Apparatus Driver/Operator Professional Qualification.*

*Additionally, a*s part of the probationary process on the company level, the probationary fire fighter is provided with additional classroom and practical training for driver/operators.

In this incident, a permanent water supply was not established in a timely manner.

Recommendation #8: Fire departments should use thermal imaging cameras (TICs) during fire-fighting operations.

Discussion: Thermal imaging cameras (TICs) provide a technology with potential to enhance fire fighter safety and improve the ability to perform tasks such as size-up, search and rescue, fire attack, and ventilation. TICs should be used in a timely manner. Fire fighters should be properly trained in the use of a thermal imaging camera and be aware of their limitations.[28, 29]

The application of thermal imaging on the fire ground may help fire departments accomplish their primary mission, which is saving lives. This mission can be accomplished in many ways. First and foremost, in near zero visibility conditions, primary searches may be completed quickly and with an added degree of safety. The use of thermal imaging technology may also be invaluable when a fire department is confronted with larger floor areas or unusual floor plans.[29] Searching for trapped civilians is part of a fire department's primary mission. At times, the search may be for a member who has become separated from the company or crew. TICs may also provide a method for fire fighters to track and locate other fire fighters in very limited visibility conditions. The TIC may provide invaluable assistance during rapid intervention crew (RIC) operations in locating a missing member of the company or crew, enhancing fire fighter accountability before an issue arises.[30]

At a structure fire, the TIC may help identify the location of the fire or the extent of fire involvement prior to fire fighters being deployed into a structure. Knowing the location of the fire may help fire fighters determine the best approach to the fire. The TIC may provide additional information for a crew making the fire attack that they would not previously have due to poor visibility and building construction. Using this information, fire fighters may be able to locate the fire more quickly and may also ensure that the water application is effective. One of the most important aspects of the TIC is that when used properly and understood it may provide the potential to detect a fire that is isolated or hidden within parts of structure.[31] While the use of a TIC is important, research by Underwriters Laboratories has shown that there are significant limitations in the ability of these devices to detect temperature differences behind structural materials, such as the exterior finish of a building or outside compartment linings (i.e., walls, ceilings, and floors).[30]

Of all the operations in which the TIC can improve fire fighters' efforts, this technology has the most dramatic impact on search and rescue. Fire fighters using thermal imagers can see the room, which enables them to quickly navigate and identify victims. Without a TIC, fire fighters search burning buildings by crawling through smoke to try and locate possible victims by feel or touch.

From a ventilation perspective, fire fighters can use the TIC to identify areas of heat accumulation, possible ventilation points, and significant building construction features. This helps ensure proper and effective ventilation that successfully removes smoke and heat from a building.

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At this incident, Truck 17's crew took the TIC to the steps of the building on Side Delta and set the TIC down on the steps. The TIC was never used for fire-fighting operations or RIT operations at this incident.

***Recommendation #9: Fire departments should ensure that the incident commander assigns a safety officer as early in the incident as possible as defined by NFPA 1561* Standard on Emergency Services Organization Incident Management System and Command Safety.**

Discussion: According to NFPA 1561 *Standard on Emergency Services Incident Management System and Command Safety,* "The incident commander shall have overall authority for management of the incident and the incident commander shall ensure that adequate safety measures are in place. This shall include overall responsibility for the safety and health of all personnel and for other persons operating within the incident management system. While the incident commander is in overall command at the scene, certain functions must be delegated to ensure adequate scene management is accomplished."[18] NFPA 1500 *Standard on a Fire Department Occupational Safety and Health Program* states, "As incidents escalate in size and complexity, the incident commander shall divide the incident into tactical-level management units and assign a safety officer (SO) who has the expertise to evaluate hazards and provide direction with respect to the overall safety of personnel."[10]

Fire departments should define the standard operating procedures for the responsibilities of a safety officer. The safety officer should be integrated into the command system and identified as a member of the command staff as early in the incident as possible with the authority to alter, suspend, or terminate activities judged to be unsafe or an imminent hazard. The Incident Action Plan should be provided to the safety officer. In the initial stage of the incident, this could be as simple as a verbal report from the incident commander. Consideration should be given to assigning assistants to the safety officer to help in covering all areas of the fire ground.[10, 32, 33, 34]

The safety officer's responsibilities and functions include:

- providing the incident commander a risk assessment of existing or potential hazards identified through a 360-degree reconnaissance of the incident scene;
- monitoring the status of rapid intervention crew(s)
- ensuring the fire department's personnel accountability system is being utilized;
- confirming that established radio communication channels have been established (Command Channel, Tactical Channels);
- ensuring an incident scene rehabilitation tactical level management component is established;
- obtaining the overall situation status and resource status of the incident;
- ensuring established safety zones, collapse zones, hot zone, and other designated hazard areas are communicated to all members on scene;
- reporting directly to the incident commander;
- recommending to the incident commander any changes to the Incident Action Plan as a result of the ongoing surveys;
- immediately informing the incident commander of any actions taken to correct imminent hazards at the emergency scene.

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When operating in forward or otherwise hazardous positions, the safety officer must be attired in appropriate personal protective equipment (PPE), including self-contained breathing apparatus (SCBA) and radio communication equipment, and be accompanied by another responder.[32, 35] Most importantly, the safety officer must not work alone if going into areas where PPE and SCBA are utilized. This ensures proper safety and personnel accountability.

Members assigned to function as a safety officer must meet the requirements of NFPA 1521 *Standard on Fire Department Safety Officer Professional Qualifications*.[32] The 2015 edition changed to a professional qualifications standard defining the necessary competencies for a member to function as a safety officer at an emergency incident.

The fire department in this incident utilizes company officers as the safety officer who is appointed on scene. The department has a Health and Safety Officer who manages the department's occupational safety and health program but does not respond after hours to emergency incidents. At this incident, Engine 19 was special-called. The time of dispatch was 1447 hours and Command assigned the officer of Engine 19 as safety officer at 1459 hours. The first Mayday occurred at 1503 hours.

Metropolitan-size fire departments should consider one or more full-time dedicated safety officer(s) who are on duty and can routinely respond to working fires (e.g., full-time shift safety officer). In smaller departments, every officer should be prepared to function as the safety officer when assigned by the incident commander. A full-time dedicated safety officer provides the expertise of an individual who focuses on on-scene safety versus tactical- and task-level functions. The dedicated safety officer gives the department a venue of putting a risk manager on scene in a very short response time.[32, 33] Having a safety officer on scene at defined incidents allows the incident commander to delegate the safety function to a trained and competent member of the department. The dedicated safety officer adds a higher level of proficiency and experience to assist the incident commander, division or group supervisors, fire officers, and fire fighters.[10, 34, 36] The presence of a safety officer does not diminish the responsibility of individual fire officers and fire fighters for their own safety and the safety of others.

In this incident, the IC was limited in his ability to assign a safety officer to arriving officers since most companies had rookie members, thus requiring the need for the officers to remain with their crews. Rookie members should always be accompanied by their officer on the fireground.

Recommendation #10: Fire departments should ensure that interior attack crews always enter a hazardous environment with a charged hoseline, especially in one or two-story structures.

Discussion: The modern fire environment can change very rapidly. Fire fighters entering the hazardous atmosphere must be prepared to rapidly apply water when interior temperatures increase, often without warning. Many fire fighters have advocated this tactical method based on previous years of experiencing successful results. Modern fuel loads have changed and industry standards do not permit entry into this environment unless fire crews are properly protected except in life saving situations.

Today's fire service has the ability to evaluate tactics based on research. As an industry, the fire service needs to re-evaluate current standard operating procedures based on research and the modern

fire environment.[11] The risks of altering actions from accepted safety procedures has been identified in the Normalization of Deviance by Colonel Mike Mullane, Retired USAF, presentation series. Just because fire crews have been successful in the practice does not solidify the safety of the practice.[37]

A dry hoseline shouldn't be charged if you can't see it due to smoke; it should be charged prior to that point. This allows you to see the objects that your hose may get caught up on when you're not in a smoke-filled environment, and it ensures you don't get caught in a rapid fire progression event without a charged hoseline. Engine companies deploying hoselines need to know the warning signs of flashover or rapid fire progression: pressurized, dark smoke; high heat; roll-over; a lowering thermal layer; and superheated air and/or pyrolysis.[38]

In this incident, Engine 3's crew made entry into a smoke-filled environment with an uncharged hoseline.

Recommendation #11: Municipalities, building owners, and authorities having jurisdiction should consider requiring sprinkler systems be installed in mixed occupancy structures.

Discussion: Fire development beyond the incipient stage is one of the greatest hazards that fire fighters are exposed to. This exposure and risk to fire fighters can be dramatically reduced when fires are controlled or extinguished by automatic sprinkler systems. NFPA statistics show that most fires in sprinklered buildings are controlled prior to fire department arrival by the activation of one or two sprinkler heads. The presence of automatic fire sprinklers also reduces the exposure risk to fire fighters in rescue situations by allowing the safe egress of building occupants before the fire department arrives on scene. Finally, by controlling fire development, the exposure to hazards such as building collapse and overhaul operations are greatly reduced, if not eliminated.

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Investigator Information

This incident was investigated by Matt E. Bowyer, General Engineer, Murrey Loflin, Investigator, and Stacy Wertman, Occupational Safety and Health Specialist, with the Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH located in Morgantown, WV. An expert technical review was provided by Sean DeCrane, Battalion Chief, Cleveland Division of Fire. A technical review was also provided by the National Fire Protection Association, Public Fire Protection Division.

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Appendix One

Self-Contained Breathing Apparatus

National Personal Protective Technology Laboratory
Technology Evaluation Branch

Disclaimer

Investigator Information
The SCBA inspection and this report were written by Thomas D. Pouchot, General Engineer. These investigators are part of the Technology Evaluation Branch, National Personal Protective Technology Laboratory, National Institute for Occupational Safety and Health, located in Bruceton, Pennsylvania. The purpose of Respirator Status Investigations is to determine the conformance of each respirator to the NIOSH approval requirements found in Title 42, *Code of Federal Regulations*, Part 84. A number of performance tests are selected from the complete list of Part 84 requirements and each respirator is tested in its "**as received**" condition to determine its conformance to those performance requirements. Each respirator is also inspected to determine its conformance to the quality assurance documentation on file at NIOSH.

In order to gain additional information about its overall performance, each respirator may also be subjected to other recognized test parameters, such as National Fire Protection Association (NFPA) consensus standards. While the test results give an indication of the respirator's conformance to the NFPA approval requirements, NIOSH does not actively correlate the test results from its NFPA test equipment with those of certification organizations which list NFPA-compliant products. Thus, the NFPA test results are provided for information purposes only. Selected tests are conducted only after it has been determined that each respirator is in a condition that is safe to be pressurized, handled, and tested.

Respirators whose condition has deteriorated to the point where the health and safety of NIOSH personnel and/or property is at risk will not be tested.

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Status Investigation Report of Two Self-Contained Breathing Apparatus Submitted By the NIOSH Division of Safety Research NIOSH Task Number 19601

The National Institute for Occupational Safety and Health (NIOSH) has concluded its investigation conducted under NIOSH Task Number TN-19601. This investigation consisted of the inspection of two Mine Safety Appliances (MSA) Company Fire Hawk 30 minute, 4500 psig, Self-Contained Breathing Apparatus (SCBA). The SCBA units in question were contained inside paper evidence bags and were delivered to the NIOSH facility in Bruceton, Pennsylvania, on April 23, 2014. The packages were taken to the National Personal Protective Technology Laboratory (NPPTL), Technology Evaluation Branch (TEB) Respirator Equipment Storage Area (building 20) and stored under lock until the time of the examination and evaluation.

SCBA Inspection:

An initial general inspection of the SCBA units was conducted on May 16, 2014. The units were identified as the MSA Fire Hawk SCBAs.

A complete visual inspection of the SCBA units was conducted on May 16, 2014. The units were examined, component by component in the condition received, to determine conformance to the NIOSH-approved configuration. The visual inspection process was photographed.

The complete SCBA inspections are summarized in Appendix I of the enclosed Status Investigation Report. The condition of each major component was photographed with a digital camera. Images of the SCBA units are contained in Appendix III of the report.

The SCBA units in question, Unit #1 and Unit #2, suffered extensive damage and the units were also covered with general dirt and grime. The Unit #1 cylinder valve as received was in the ¼ opened position. The cylinder gauge was not readable and there was no air remaining in the cylinder.

The cylinder valve hand wheel could be turned on Unit #1 but the hand wheel was damaged by heat. The Unit #1 second stage regulator and facepiece were missing from the SCBA assembly. The PASS device on the unit did not function. The NIOSH approval label was present on the unit.

The Unit #2 cylinder valve as received was in the opened position. The cylinder gauge was not readable and there was no air remaining in the cylinder.

The cylinder valve hand wheel could be turned on Unit #2 but the hand wheel was damaged by heat. The Unit #2 second stage regulator and facepiece were missing from the SCBA assembly. The PASS device on the unit did not function. The NIOSH approval label was present on the unit.

Also, these SCBAs were equipped with a data logging devices that measures several performance parameters during a predetermined time period. On June 19, 2014, representatives for the Mine Safety Appliances Company (MSA) down loaded the data loggers included with these SCBA units. The data download was performed at the MSA facility in Cranberry Township, Pennsylvania and the download was witnessed by NIOSH and Fire Department personnel.

Personal Alert Safety System (PASS) Device

The Personal Alert Safety System (PASS) devices on Unit #1 and Unit #2 were not operable and functional. However, the units were not tested against the specific performance requirements of NFPA 1982, *Standard on Personal Alert Safety Systems, (PASS),* 1998 Edition. Because NIOSH does not certify PASS devices, no further evaluation was performed.

SCBA Compressed Air Cylinder Contents

During the inspection, it was noted that the compressed air cylinders did not have pressure remaining. Therefore, no air sample could be collected for analysis.

SCBA Testing

The purpose of the testing was to determine the conformance of the SCBA units to the approval performance requirements of Title 42, *Code of Federal Regulations*, Part 84 (42 CFR 84). Further testing is conducted to provide an indication of the conformance of the SCBA unit to the National Fire Protection Association (NFPA) Air Flow Performance requirements of NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus for the Fire Service*, 1997 Edition.

NIOSH SCBA Certification Tests (in accordance with the performance requirements of 42 CFR 84):

1. Positive Pressure Test [§ 84.70(a)(2)(ii)]
2. Rated Service Time Test (duration) [§ 84.95]
3. Static Pressure Test [§ 84.91(d)]
4. Gas Flow Test [§ 84.93]
5. Exhalation Resistance Test [§ 84.91(c)]
6. Remaining Service Life Indicator Test (low-air alarm) [§ 84.83(f)]

National Fire Protection Association (NFPA) Tests (in accordance with NFPA 1981, 1997 Edition):

7. Air Flow Performance Test [Chapter 5, 5-1.1]

Testing was not conducted on either Unit #1 or Unit #2 due to the extensive damage present.

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Summary and Conclusions

Two SCBA units were submitted to NIOSH by the NIOSH Division of Safety Research (DSR) for the Ohio Fire Department for evaluation on April 23, 2014. The SCBA units were initially inspected on May 16, 2014. The units were identified as a Mine Safety Appliances (MSA) Company Fire Hawk, 30 minute, 4500 psig SCBA (NIOSH approval numbers TC-13F-548CBRN). An in-depth inspection of the SCBA units was conducted on May 16, 2014. The units were in poor condition with extensive damage. The cylinders included were covered in dirt and soot and black in color, therefore, a determination of the cylinder certifications could not be made as it is required to be recertified every 5 years. The SCBA units were covered with dirt and soot.

The integrated PASS units could not be activated and did not appear to function.

An air sample was not taken and analyzed from the compressed air cylinders as there was no air remaining in the cylinders.

Both SCBA Unit #1 and Unit #2 were not tested due to the extensive damage.

On June 19, 2014, representatives of the Mine Safety Appliances Company (MSA) down loaded the data loggers included with these SCBA units. The data downloads were performed at the MSA facility in Cranberry Township, Pennsylvania and the downloads were witnessed by NIOSH and Fire Department personnel. Attached are the SCBA cylinder pressure versus time charts for both fire fighters. Please note the cylinders were close to full and the duration was 14 minutes and 15 minutes, respectively. Places where the graph indicates a sudden drop in pressure suggests that that the by-pass was used for cool air, the face piece may have dislodged, or the face piece seal was broken by accident or on purpose.

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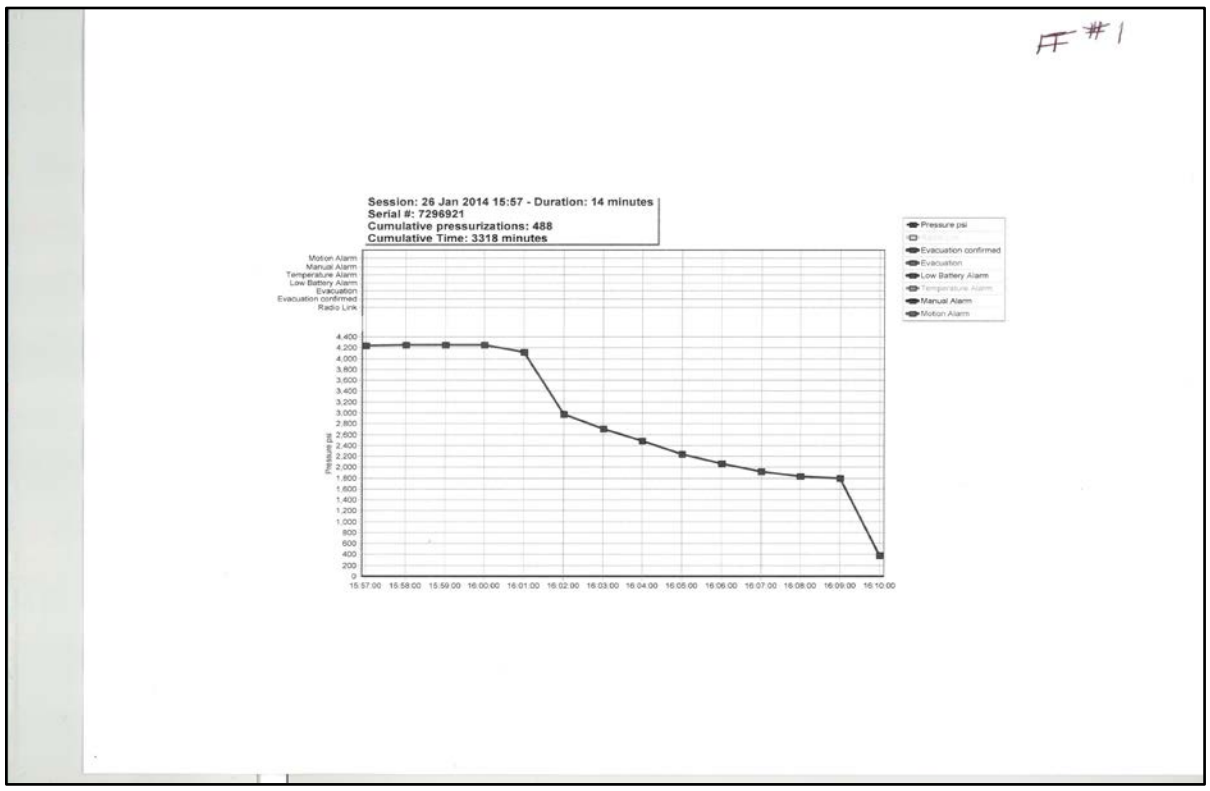

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